Optical and Electrical Properties of $Cu_2ZnSnSe_4$ and $Cu_2ZnSnS_2Se_2$ Thin Films

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Thin films of $Cu_2ZnSnSe_4$ and $Cu_2ZnSnS_2Se_2$ were obtained by thermal evaporation of previously synthesized materials and determined their optical coefficients.

Measurement of optical coefficients were performed on Nicolet 6700 spectrometer in the wavelength range λ = 0.9 – 26.6 microns and spectrometer СФ-2000 in the range of wavelengths λ = 0.4 – 1.1 microns. The optical properties of thin films $Cu_2ZnSnSe_4$ and $Cu_2ZnSnS_2Se_2$ (their refractive index $n(\lambda)$, absorption coefficient $\alpha(\lambda)$, and extinction coefficient $k(\lambda)$) can be assessed by independent reflectance and transmittance measurements (fig. 1).

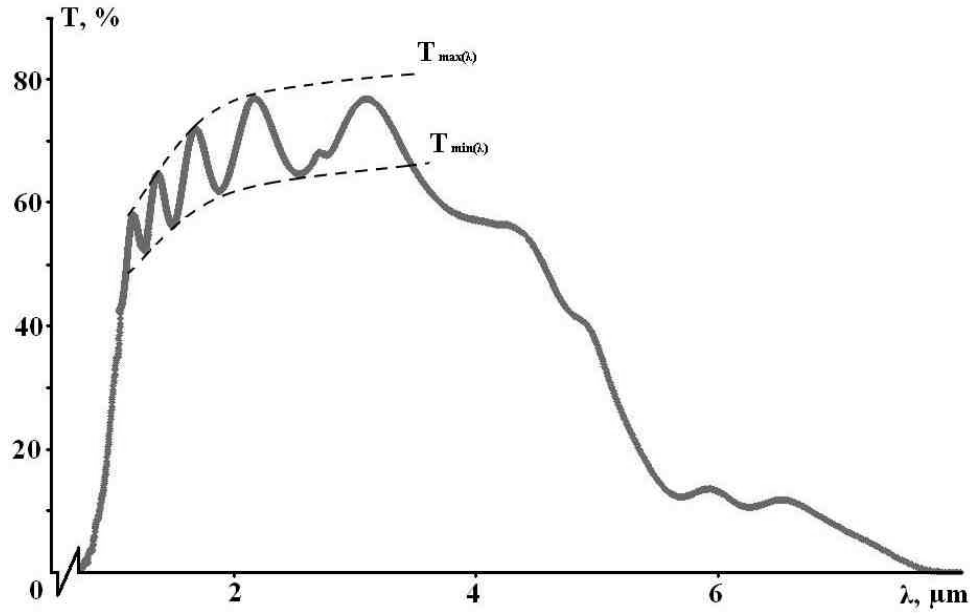

Fig. 1. Dependency of transmission coefficient on wavelength of electromagnetic radiation at T = 300 K for thin film $Cu_2ZnSnS_2Se_2$

By extrapolating the linear portion of the plot of $\alpha^2 = f(h\nu)$ against $h\nu$ to zero absorption coefficient the optical band gap of the thin films was determined to be $E_g \approx 1.39$ eV for $Cu_2ZnSnSe_4$ and $E_g \approx 1.38$ eV for $Cu_2ZnSnS_2Se_2$.

The sheet resistance R_s of a thin film $Cu_2ZnSnSe_4$ and $Cu_2ZnSnS_2Se_2$ (whose thickness is much smaller than a typical contact separation) is the resistance of a square sheet of the film, specified in unit of "ohms per square". The sheet resistance of a sample in the form of a rectangle depends not on its linear dimensions but on its length-to-width ratio L/W: $R_s = RW/L$, where R is the measured resistance.

The calculated room-temperature R_s value is 98.5 kΩ/square for $Cu_2ZnSnSe_4$ and 21.2 kΩ/square for $Cu_2ZnSnS_2Se_2$. Since the film thickness is for $Cu_2ZnSnSe_4$ d = 2.79 μm, we obtain ρ = 27.48 Ω cm and for $Cu_2ZnSnS_2Se_2$ d = 1.36 μm, we obtain ρ = 2.88 Ω cm.